REMARKS

Reconsideration of the present application is respectfully requested in view of the foregoing amendments and the remarks which follow.

Applicants appreciate the Examiner's participation in an interview on November 10, 2010 and agree with the Interview Summary issued on November 12, 2010.

I. Status of the Claims

Applicants have amended claims 1, 10, and 16-18 to correct various informalities and spelling errors. New claim 24 has been added. No new matter has been introduced. Claims 4-9, 11, and 19-23 were previously canceled. Following entry of these amendments, claims 1-3, 10, 12-18 and 24 are pending in the application.

II. Rejections under 35 U.S.C. § 103

A. Rejection based on Pope and Rubin

Claims 1, 2, 10, and 12-15 were rejected under 35 U.S.C. § 103(a) over U.S. Patent No. 6,655,845 to Pope (hereafter "Pope"), in view of U.S. Patent No. 5,064,547 to Rubin (hereafter "Rubin"). Applicants respectfully traverse this rejection for at least the following reasons.

First, claims 1, 2, 10 and 12-15 are not obvious based on Pope and Rubin because there is no motivation to combine these references. The Supreme Court in *KSR Int'l Co. v. Teleflex, Inc.* 550 U.S. 398 (2007) clarified the standards for obviousness and stated that "a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the art .... [I]t can be important to ***identify a reason*** that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does." *KSR*, 550 U.S. at 401. In addition, MPEP 2143.01 provides:

> A statement that modifications of the prior art to meet the claimed invention would have been "well within the ordinary skill of the art at the time the claimed invention was made" because the references relied upon

> teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references. *Ex parte Levengood*, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993). "***[R]ejections on obviousness cannot be sustained by mere conclusory statements***; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *KSR*, 550 U.S. at ___, 82 USPQ2d at 1396 quoting *In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006).

The Examiner does not allege that either Pope or Rubin provides a motivation to combine. To the contrary, concerning the cited references, Pope discloses a bearing having roller and race whose surface is coated with polycrystalline diamond. Rubin discloses a lubricant composition containing saturated dicarboxylic acid having 6 to 32 carbon atoms. Accordingly, these references merely teach separately using diamond coating and using an oxygen-containing organic compound contained in lubricating oil. These references never teach or suggest the technical idea of applying the oxygen-containing organic compound at the DLC sliding surface. Nor do they suggest the positive achievements of the combination of the oxygen-containing organic compound and the DLC coated sliding member and remarkable friction reduction and wear resistance improvement effects obtained by the combination.

In such situations, "the proper question is whether the ordinary artisan possesses knowledge and skills rendering him capable of combining the prior art references." MPEP § 2143(G) (citing *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356, 1368 (Fed. Cir. 2006)). In order to possess the knowledge that would motivate one skilled in the art to combine Pope and Rubin, the skilled artisan would necessarily require knowledge of the mechanism that allows a low-friction agent containing an oxygen-containing organic compound to interact with a DLC coated sliding member in such a way that friction is drastically reduced. As will now be discussed, such knowledge was simply not available to the skilled artisan until it was discovered by the Applicants.

Second, the claimed invention is distinguished in its features from the prior art. The present invention is directed to a low-friction sliding mechanism that can improve the friction characteristics of various sliding surfaces in, for instance, internal combustion engines, drive system transmission units, manual transmissions and final reduction gear units. The present invention offers reduction of friction coefficients and improvements in seizure resistance and wear resistance, improving the fuel economy of an automobile.

The low-friction sliding mechanism of the present invention is based on the Applicants' finding that excellent low friction characteristics, which cannot be absolutely realized under conventional lubrication theory, can be provided by combining a sliding member (DLC coated sliding member) coated at its sliding surface with DLC and a lubricant (low friction agent composition) containing a specified compound. This finding was the result of investigations into the compatibility between the sliding member and the lubricant.

Specifically, in the low-friction sliding mechanism of the present invention, the low-friction agent composition is present between the sliding surfaces of the DLC coated sliding member (A) and a sliding member (B). A base material coated with diamond-like carbon is used as the DLC coated sliding member (A) whereas metal material, non-metal material and/or coated material obtained by coating a thin film on a surface of the metal material or the non-metal material is used as the sliding member (B). The low-friction agent composition contains at least one oxygen-containing organic compound (C) selected from the group consisting of alcohols, esters, ethers, ketones, aldehydes, carbonates and derivatives thereof.

In this sliding mechanism, by combining the diamond-like carbon coating film and the low-friction agent composition containing the above-mentioned specified oxygen-containing compound, extremely excellent low-friction characteristics can be obtained as compared with those obtained by conventional combination of a sliding member and lubricant. For example, in a manual transmission provided with the above sliding mechanism and according to the present invention, friction coefficients of various sliding sections such as bearing sections can be effectively lowered. As another example, applying the present invention in a final reduction gear unit, the friction coefficient between the back

side surface of a side gear and the inner surface of a differential case can be effectively lowered. In any of the above cases, seizure resistance and wear resistance can be improved while sliding resistance at various sections can be effectively lowered, thereby contributing to improvement in the fuel economy of an automotive vehicle.

The prior art does not teach the achievement of such results. These results are also discussed in the reference, Kano et. al, *"Ultralow friction of DLC in the presence of glycerol mono-oleate (GMO)"*, which is being concurrently filed herewith in an Information Disclosure Statement.

Third, in the present invention, the reason why friction coefficients can be remarkably lowered thereby to obtain excellent friction characteristics is by interposing the low-friction agent composition containing the oxygen-containing organic compound (C) (referred to as "compound C" hereinafter) between the sliding surface of the DLC coated sliding member (A) (referred to as "A member" hereafter) and the sliding surface of the sliding member (B) (referred to as "B member" hereinafter). This combination is not taught in the prior art. This

Concerning the "compound C", there is an unobvious result achieved from the use of alcohols having an OH group at their terminal end as the compound C. When the A member comes into contact with the compound C, OH group is formed at the surface of the A member. (There is no problem if a slight amount of hydrogen is additionally contained in the A member.) A hydrogen atom (H) of an OH group thus formed at the surface of the A member is bonded to an oxygen atom (O) present in the skeleton of the compound C by a hydrogen bond, thereby forming an interface structure as if the A member was covered with a film of the compound C (referred to as "sliding film" or "tribo-film" hereinafter).

In this sliding film (i.e., tribo-film), an oxygen atom of the compound C is attracted to the side of an OH group at the surface of the A member. Therefore, the oleophilic section (specifically alkyl group and the like) of the compound C is oriented to the opposite side of the OH group, i.e., to the surface side of the B member which is an opposite member in sliding.

Accordingly, the A member and the B member slide to each other in a condition where the oleophilic section of the compound C in the above-mentioned tribo-film is in contact with the B member. An oleophilic section having good friction characteristics and exhibiting a low friction coefficient is obtained..

In contrast, in conventional sliding mechanisms and the like, the lubricating component is merely in contact with or attached to sliding surface under the action of a weak "van der Waals" force, so that the lubricating component will be easily detached from the sliding surface during sliding. However, according to the present invention, the oxygen-containing compound (for example, alcohols) serving as a lubricating component continues to firmly cover the sliding surface like a film during sliding, owing to the above-mentioned hydrogen bond. Consequently, the sliding member continues to contact the opposite member in sliding.

Thus, in the present invention, when the A member and the B member slide against each other, sliding occurs in a condition in which the oleophilic section of the tribo-film formed with the compound C is in contact with the surface of the B member, thereby avoiding direct-contact sliding between the A member and the B member and providing excellent friction characteristics.

For compounds (C) other than alcohols, these compounds do not have an OH group. At the initial period of sliding between the A member and the B member, bonds of an oxygen atom forming part of the skeleton of the compound C undergo cutting, thereby forming an OH group at the surface of the A member. However, after the OH group is formed, the mechanism is the same as in the above case of alcohols. An oxygen atom of the compound C is attracted to the side of an OH group at the surface of the A member. Therefore, the oleophilic section (specifically alkyl group and the like) of the compound C is oriented to the opposite side of the OH group, i.e., to the surface side of the B member which is an opposite member in sliding.

Fourth, the unexpected results An example of this mechanism is demonstrated in the reference document included in the Information Disclosure Statement filed concurrently with this Response. This reference document, Kano et. al, "*Ultralow friction of DLC in presence of glycerol mono-ole ate (GMO)*," is closely related to the present invention and

was authored by many of the inventors of the present invention. This reference document reports a case of using, as the compound C, esters having OH group at its terminal end , specifically glycerol mono-oleate (GMO).

In this document, as shown in Figure 2 of this reference document, the friction coefficient was measured on combination of a variety of lubricating oils with a DLC coated sliding member (A member). As a result, it is apparent that the friction coefficient is lowered as the hydrogen content of DLC is less when poly-alpha-olefin (PAO) and GMO were combined. As shown in Figure 2, when comparison is made between two cases, one of which uses GMO and the other uses no GMO, for DLC containing no hydrogen, the case using GMO is lowered in friction coefficient as compared with the other case. From this, it was discovered that a beneficial reaction is produced between GMO and DLC, thereby lowering the friction coefficient.

Furthermore, from the results in Figure 3 of the reference document, it was discovered that the claimed tribo-film is excellent in friction characteristics. A low friction coefficient is formed near or within 6 nm ofthe surface of the DLC coated sliding member.

Moreover, as shown in Figure 6 of the reference document, a variety of compounds originated from GMO were observed near the surface of the DLC coated sliding member. Upon taking this into consideration together with the results of Figure 7 of the reference document, it is apparent that GMO undergoes cutting by a variety of compounds and is adsorbed to the surface of the DLC coating film thereby forming an OH group at the surface of the DLC coating film. This forms the tribo-film. Additionally, bonds in the GMO molecule may undergo cutting during sliding. However, it is believed that the cut molecule forms an OH group at the surface of the DLC coating film before the next sliding begins, upon which this OH group is bonded to the terminal of GMO thereby forming the tribo-film and providing a friction coefficient lowering effect.

As discussed above, the present invention has been made upon such knowledge that a tribo-film hydrogen bond is formed by interposing certain oxygen-containing compounds C between the A member and the B member when the members slide against each other. This knowledge has been obtained by analyzing a variety of experimental data. As noted above, in order to possess the knowledge that would motivate one skilled in the art to

combine Pope and Rubin, the skilled artisan would necessarily require this knowledge that was simply not available to the skilled artisan at the time the invention was made. According to the MPEP, "[i]t is difficult but necessary that the decisionmaker forget what he or she has been taught . . . about the claimed invention and cast the mind back to the time the invention was made (often as here many years), to occupy the mind of one skilled in the art." MPEP § 2141.01(III) (citing *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984)). Because one skilled in the art would could not have had the knowledge that would provide a motivation to combine Pope and Rubin, the Office should not find that the present invention is obvious over these references.

In other words, the present inventors have found a conventionally unknown and new interaction between a DLC coated sliding member (A) and an oxygen-containing organic compound (C), in which the creation of specified tribo-films produces excellent friction characteristics between the A member and the B member.

In view of the above, it is believed that claims 1-2, 10, and 12-15 are not obvious over the cited references, which merely recite certain organic compounds without disclosing any experimental data relating to sliding and friction.

B. Rejection based on Pope and Buckley

Claims 1, 2, 10 and 12-15 were rejected under 35 U.S.C. § 103(a) over Pope, in view of U.S. Patent No. 5,108,633 to Buckley III (hereafter "Buckley"). Applicants respectfully traverse this rejection for at least the following reasons.

The Examiner alleges that Buckley teaches a low friction agent composition that contains an aliphatic compound. *See* Office Action, page 4. The aliphatic amine compound of the present invention (as claimed) has carbon atoms ranging from 6 to 30. However, in Buckley, the long chain hydrocarbyl component of the long chain aliphatic hydrocarbyl amine has at least 50 carbon atoms; Therefore, the aliphatic amine compound disclosed in this reference is outside the range of the present invention. Additionally, this aliphatic hydrocarbyl amine is used as a dispersant and not for the purpose of lowering friction as in the present invention.

In response, the Examiner asserts on page 4 of the Office Action that Buckley teaches carbon lengths of 6-12, 2-40, 1-10, and 1-6. Applicants respectfully disagree with this assertion. As a matter of fact, the carbon length between 6 and 12 pointed out by the Examiner is a carbon chain length of alpha olefin which is a raw material of PAO serving as a synthetic base oil. Thus, the carbon length between 6 and 12 pointed by the Examiner has no relation to the carbon chain length of the aliphatic amine compound of the present invention. The carbon lengths of 2-40, 1-10, and 1-6 pointed out by the Examiner refer to a polyamine or polyamine substitute, which is a raw material of a aliphatic hydrocarbyl amine additive. Again, this has nothing to do with the carbon chain length of the aliphatic amine compound of the present invention. Hence, Buckley is not tenable as a pertinent citation.

Accordingly, Pope and Buckley cannot render the present invention obvious taken in combination. Additionally, it is a matter of course that neither of Pope and Buckley teaches the combination of diamond-like carbon and a low friction agent composition containing the claimed particular organic compound, and the significant advantages gained thereby. Further, neither of Pope and Buckley teaches the claimed content ranges (0.05 to 3.0 % mass) of the oxygen-containing organic compound and the aliphatic amine compound.

The Examiner indicated at the November 10, 2010 interview and in the November 12, 2010 Interview Summary that this argument would overcome Buckley when formally presented. Thus, it was agreed that claims 1-2, 10, and 12-15 are not unpatentable over Pope in view of Buckley. Favorable reconsideration of the rejection is respectfully requested.

C. Rejections based on Pope, Rubin, and Veerasamy

Claims 3 and 16-18 stand rejected under 35 U.S.C. § 103(a) as allegedly being obvious over Pope in view of Rubin and further in view of U.S. Patent No. 7,067,175 to Veerasamy (hereafter "Veerasamy"). Claim 3 depends from independent claim 1. The arguments above with respect to claims 1, 2, 10, and 12-15 also apply to claims 16-18. Veerasamy does not remedy the deficiencies of Pope and Rubin noted above. Thus, claims 3 and 16-18 are allowable over Pope, Rubin, and Veerasamy.

D. Rejections based on Pope, Buckley, and Veerasamy

Claims 3 and 16-18 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Pope, in view of Buckley, and further in view of Veerasamy. Claim 3 depends from independent claim 1. The arguments above with respect to claims 1, 2, 10, and 12-15 also apply to claims 16-18. Veerasamy does not remedy the deficiencies of Pope and Buckley noted above. Thus, claims 3 and 16-18 are allowable over Pope, Buckley, and Veerasamy.

III. Allowability of Claim 24

The Examiner indicated at the November 10, 2010 interview and in the Interview Summary issued November 12, 2010 that "claiming the specific esters would overcome the prior art of record, Rubin, as applied . . . ." *See* Interview Summary, Continuation Sheet. Accordingly, new claim 24 includes the limitation that the low friction agent composition comprises an ester, and the ester comprises at least one kind selected from the group consisting of glycerin monooleate, glycerin dioleate, sorbitan monooleate, sorbitan dioleate, and any combination of these. Therefore, claim 24 is allowable over the prior art of record.

IV. Conclusion

Applicants believe that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested. The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application. The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing or a credit card payment form being unsigned, providing incorrect information resulting in a rejected credit card transaction, or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicants hereby petition for such extension under 37 C.F.R. §1.136 and authorizes payment of any such extensions fees to Deposit Account No. 19-0741.

Respectfully submitted,

Date DEC 29 2010

By Michael D. Kaminski

FOLEY & LARDNER LLP
Customer Number: 22428
Telephone: (202) 672-5490
Facsimile: (202) 672-5399

Michael D. Kaminski
Attorney for Applicant
Registration No. 32,904